

A SIMPLE METHOD FOR ESTIMATION OF COAGULATION EFFICIENCY
IN MIXED AEROSOLS

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ABSTRACT

Two aerosols of particles that can react to form a photo-reducible compound can be used to measure coagulation efficiency. Aerosols of KBr and AgNO₃ were mixed, exposed to light in a glass tube and collected in the dark. About 15% of the collected material was reduced to silver upon development.



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We needed an approximate measurement of the coagulation efficiency of mixed aerosols generated from two Wells-type refluxing atomizers to be used in another experiment where a restrictive orifice seemed to increase coagulation. With non-homogeneous aerosols, and with unknown conditions of turbulence in inlet tubing to an aerosol chamber, and no knowledge of electrostatic charge on the particles or true particulate number, it was impossible to calculate an expected value for our particular set up.

After consideration of several methods, it became evident that a three-phase system was needed; i.e., two types of aerosols (A and B) and a "catalyst" that could form a reaction product from collisions of A and B only while the coagulated particles were airborne and not after they had been collected (e.g., in an impinger).

The system finally chosen consisted of mixed aerosols of AgNO_3 (2%) and KBr (2%) conducted through a glass tube (2.3 cm ID, 90 cm long) irradiated by a 300 watt incandescent lamp prior to collection in distilled water

contained in AGI-30 impingers either enclosed in aluminum foil or not, depending upon whether the coagulation product of silver or the total possible production of silver was the desired datum. The selected concentrations corresponded to the dissolved solids used in the other experiment.

The experimental set up is shown in Figure 1. The combined air output of the two Wells-type atomizers was about 18 liters per minute and the collection rate of the impingers was 12.5 liters per minute, so back-flow of room air was negligible. The mass median diameter of equilibrated particles from these atomizers was about 2.3 μm and the distribution was approximately log-normal. Without the orifice, which was a disk with a central hole one-half the diameter of the copper tubing, flow in the tubing was only marginally turbulent (Reynolds, number 4×10^3).

The procedure to establish standards was to operate both atomizers simultaneously, collect the output in a 20 ml volume of water for 30, 60, 90, 120, and 150 second intervals, add 0.25 ml of developer (Kodak DK 50), allow the impinger to remain in the light for 15 minutes, add 0.25 ml of fixative (Kodak Rapid Fixer) and determine the optical density (OD) at 640 nm. The OD values were plotted against percentage recovered, with 150 seconds collection as 100 percent (Fig. 2). This range of intervals represent the useful limits of the system under these conditions.

To estimate coagulation efficiency, the impinger was wrapped in foil and the mixed aerosols were collected in a darkened room for a 5-minute

interval. Thus, only silver cations that had contacted bromine anions in the lighted tube would form silver after development. Developer was immediately added to the impinger fluid via an hypodermic needle through the rubber tubing connected to the inlet tube, fixative was added after two minutes and the OD was then determined as before.

Initially, tests were made without the orifice (Fig. 1) and coagulation efficiency was less than 5%; i.e., barely detectable by the method used. When the orifice was inserted, values of coagulation between 15 - 21% were found. Values for coagulation are shown in Fig. 2. We believe this variability was influenced by differences in resonances in the tee section (and hence, different turbulence) caused by unequal starting of the two atomizers and by the fact that the glass inlet tube to the impinger could have served as a "light pipe". We have not investigated either possibility.

Although our interest was only to obtain an estimate of coagulation under special conditions, we believe the method could be improved. For example, the ends of the inlet and outlet tubes of the impinger could be ground and painted black to reduce stray light, or an impinger could be constructed of metal or opaque plastic, or another sampling method might be used. The silver could be measured by oxidometric methods, or by volt-ammetry, after removal of the soluble silver salts.

If it can be demonstrated that an aerosol developer can function as a developer or an aerosol of fixer as a fixer, the possibilities would

exist of a study of interactions of aerosols composed of 3 or 4 species of particles. Other variables, such as number and sizes of particles, and their ratios, are also amenable to study.

Finally, the method described here measures only the A-B coagulation fraction, which is only one-half of the total coagulation in the mixed aerosols containing A-A and B-B fractions.

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Figure 1. Experimental set-up to measure coagulation

Legend: The copper tube was 1.5 cm inside diameter and 33 cm long,
and was bent to permit later use within a closed hood.

Figure 2. Relationship between mass of aerosols of AgNO_3 and KBr collected and optical density after development. Percentages for coagulation shown must be divided by two to correct for 5-minute sample.



